Claims

[c1] 1. A device to process material, comprising:
an energy beam source to generate an energy beam; and
at least one energy beam transfer device operatively connectable to the energy beam source and disposable relative to a workpiece, to direct the energy beam in a predetermined pattern on an exterior surface of the workpiece to be processed.

[c2] 2. The device of claim 1, wherein the energy beam source comprises one of an electron beam system or a laser material processing system.

[c3] 3. The device of claim 1, wherein the energy beam transfer device comprises a lens.

[c4] 4.The device of claim 1, further comprising:
a plurality of energy beam transfer devices; and
a switching device to apply the energy beam to each energy beam transfer device to direct the energy beam.

[c5] 5. The device of claim 4, further comprising a housing to enclose the energy beam transfer devices and at least a portion of the workpiece to be processed, wherein the housing includes:

a first part; and
a second part, wherein the first part and the second part are movable relative to one another to releasably enclose at least the portion of the workpiece to be processed.

[c6] 6. The device of claim 5, further comprising:
a first transfer device support coupled to an interior of the first part of the housing to support a first group of the plurality of energy beam transfer devices; and
a second transfer device support coupled to an interior of the second part of the housing to support a second group of the plurality of energy beam transfer devices.

[c7] 7. The device of claim 5, further comprising a workpiece fixture to retain the workpiece in position relative to each of the plurality of transfer devices during a material processing operation.

[c8] 8. The device of claim 7, wherein the workpiece fixture comprises a plurality of centering pins to hold the workpiece in position.

[c9] 9. The device of claim 8, wherein the workpiece fixture further comprises:
a first pin support coupled to an interior of the first part of the housing to support a first group of pins of the plurality of centering pins; and

a second pin support coupled to an interior of the second part of the housing to support a second group of pins of the plurality of centering pins.

[c10] 10. The device of claim 5, wherein the housing is adapted to form a seal around the workpiece to retain the energy beam and any debris within the housing during a material processing operation.

[c11] 11. The device of claim 5, further comprising a tool positioner including:
a first operating lever; and
a second operating lever pivotally coupled to the first operating lever to hold the housing in position on the workpiece during a material processing operation.

[c12] 12. The device of claim 4, further comprising a fiber optic cable to operatively connect each of the energy beam transfer devices to the energy beam source.

[c13] 13. The device of claim 1, wherein the device is adapted to operate in at least one of substantially a vacuum and substantially a zero gravity environment.

[c14] 14. The device of claim 1, wherein the workpiece comprises a component on an aerospace vehicle.

[c15] 15.The device of claim 1, wherein the predetermined

pattern is substantially completely around the exterior surface of the workpiece.

[c16] 16. A device to process material, comprising:
a housing to substantially enclose at least a portion of a workpiece to be processed;
an energy beam source to generate an energy beam; and
means to direct the energy beam on at least one predetermined location on the portion of the workpiece enclosed within the housing.

[c17] 17. The device of claim 16, wherein the means to direct the energy beam comprises a plurality of energy beam transfer devices operatively connectable to the energy beam source and distributable around the workpiece to direct the energy beam in a predetermined pattern on an exterior surface of the workpiece.

[c18] 18. The device of claim 17, further comprising a switching device to apply the energy beam to each transfer device.

[c19] 19. The device of claim 17, wherein the housing comprises:
a first part; and
a second part, wherein the first part and the second part are movable relative to one another to releasably enclose

at least the portion of the workpiece.

[c20] 20. The device of claim 19, further comprising:
a first transfer device support coupled to an interior of the first part of the housing to support a first group of the plurality of energy beam transfer devices; and
a second transfer device support coupled to an interior of the second part of the housing to support a second group of the plurality of energy beam transfer devices.

[c21] 21. The device of claim 19, further comprising a workpiece fixture to retain the workpiece in position relative to each of the plurality of transfer devices during a material processing operation.

[c22] 22. The device of claim 19, wherein the housing is adapted to form a seal around the workpiece to retain the energy beam and any debris within the housing during a material processing operation.

[c23] 23. The device of claim 16, wherein the means to direct the energy beam comprises:
a movable frame; and
an energy beam transfer device mounted to the movable frame and operatively connectable to the energy beam source, the energy beam transfer device to direct the energy beam on the at least one predetermined location on

the workpiece.

[c24] 24. The device of claim 23, further comprising a drive mechansim to move the moveable frame relative to the workpiece.

[c25] 25. The device of claim 24, further comprising at least one drive wheel or gear to move the movable frame relative to the workpiece.

[c26] 26. The device of claim 25, further comprising a controller operatively connected to the at least one drive wheel or gear to move the movable frame to a predetermined location relative to the workpiece.

[c27] 27. The device of claim 25, wherein the movable frame comprises:
a substantially horseshoe shaped member including:
an interior portion adapted to receive and retain the workpiece; and
a substantially circular exterior portion to engage the at least one drive wheel or gear to move the movable frame relative to the workpiece.

[c28] 28. The device of claim 25, further comprising a material processing head mounted to and extending at least partially within the housing.

[c29] 29. The device of claim 28, wherein the at least one drive wheel or gear is rotatably mounted to the material processing head.

[c30] 30. A device to inspect a workpiece, comprising:
a movable frame;
a laser holographic exciter mounted to the movable frame; and
at least one laser reader mounted to the movable frame, wherein the movable frame is adapted to be movable relative to the workpiece during an inspection process.

[c31] 31. The device of claim 30, further comprising a drive mechanism to move the movable frame relative to the workpiece.

[c32] 32. The device of claim 31, further comprising a workpiece support member attached to the movable frame and adapted to engage and move relative to the workpiece during an inspection process.

[c33] 33. The device of claim 31, further comprising at least one drive wheel or gear to move the movable frame relative to the workpiece.

[c34] 34. The device of claim 33, wherein the movable frame comprises a substantially horseshoe shaped member including:

an interior portion adapted to receive and retain the workpiece; and

a substantially circular exterior portion to engage the at least one drive wheel or gear to move the movable frame relative to the workpiece.

[c35] 35. The device of claim 33, further comprising a housing to enclose at least the movable frame and at least a portion of the workpiece under inspection, wherein the housing includes:

a first part; and

a second part movable relative to the first part to releasably enclose at least the portion of the workpiece under inspection.

[c36] 36. The device of claim 35, further comprising an inspection head mounted to at least one of the first and second parts of the housing and extending at least partially within the housing.

[c37] 37. The device of claim 36, wherein the at least one drive wheel or gear is rotatably mounted to the inspection head.

[c38] 38. The device of claim 35, wherein the laser holographic exciter discharges laser light and the housing is adapted to form a seal around the workpiece to retain the laser

light within the housing during inspection.

[c39] 39. The device of claim 30, further comprising:
a laser holographic emitter; and
a fiber optic cable to operatively connect the laser holographic emitter to the laser holographic exciter.

[c40] 40. A device to process material, comprising:
a base member adapted to releasably hold a portion of material to be attached to a workpiece;
a track mounted to the base member; and
a material processing system adapted to move along the track to perform a material processing operation.

[c41] 41. The device of claim 40, further comprising:
a drive motor; and
a carriage drive arm to couple the material processing system to the drive motor to move the material processing system along the track.

[c42] 42. The device of claim 40, wherein the material processing system comprises one of an energy beam system or a laser material processing system.

[c43] 43. The device of claim 40, further comprising a laser holographic inspection system adapted to move along the track to perform an inspection operation on the workpiece.

[c44] 44. The device of claim 43, further comprising:
a drive motor; and
a carriage drive arm to couple the laser holographic system to the drive motor to move the laser holographic system along the track.

[c45] 45. The device of claim 40, wherein the processing operation comprises at least one of joining, welding, cutting, and inspecting.

[c46] 46. The device of claim 40, wherein the workpiece is an aerospace vehicle.

[c47] 47. The device of claim 40, wherein the portion of material is an ISO grid repair patch.

[c48] 48. A device to process material, comprising:
a base member;
a first track mounted to the base member;
a carriage including a bottom portion and a top portion, the bottom portion being adapted to move along the first track;
a second track slidably mounted to the top portion of the carriage; and
a material processing system mounted to the second track to perform a material processing operation on a workpiece.

[c49] 49. The device of claim 48, further comprising:
a drive motor; and
a carriage drive arm to couple the material processing system to the drive motor to move the material processing system along the first track.

[c50] 50. The device of claim 48, further comprising:
a second carriage including a bottom portion and a top portion, the bottom portion being adapted to move along the first track;
a third track slidably mounted to the top portion of the second carriage; and
a laser holographic inspection system mounted to the third track to perform an inspection operation on the workpiece.

[c51] 51. The device of claim 50, further comprising a carriage drive arm to couple the laser holographic system to the drive motor to move the laser holographic system along the track.

[c52] 52. A device to inspect a workpiece, comprising:
a base member;
a track mounted to the base member; and
an inspection system adapted to move along the track to perform an inspection operation on a workpiece.

[c53] 53. The device of claim 52, further comprising:
a drive motor; and
a carriage drive arm to couple the inspection system to the drive motor to move the inspection system along the track.

[c54] 54. The device of claim 52, wherein the inspection system comprises a laser holographic inspection system.

[c55] 55. A method of making a device to process material, comprising:
providing an energy beam source to generate an energy beam;
disposing at least one energy beam transfer device to direct the energy beam in a predetermined pattern on an exterior surface of a workpiece; and
operatively connecting the at least one energy beam transfer device to the energy beam source.

[c56] 56. The method of claim 55, wherein providing the energy beam source comprises providing one of an electron beam system or a laser material processing system.

[c57] 57. The method of claim 55, wherein disposing the at least one energy beam transfer devices comprises disposing a plurality of lenses relative to the workpiece.

[c58] 58. The method of claim 55, further comprising providing a switching device to apply the energy beam to each transfer device of a plurality of transfer devices to direct the energy beam at predetermined locations on the exterior surface of the workpiece.

[c59] 59. The method of claim 58, further comprising forming a housing to enclose at least the energy beam transfer devices and at least a portion of the workpiece to be processed, wherein forming the housing includes:
providing a first part; and
providing a second part movable relative to the first part to releasably enclose the portion of the workpiece to be processed.

[c60] 60. The method of claim 59, further comprising:
coupling a first transfer device support to an interior of the first part of the housing to support a first group of the plurality of energy beam transfer devices; and
coupling a second transfer device support to an interior of the second part of the housing to support a second group of the plurality of energy beam transfer devices.

[c61] 61. The method of claim 59, further comprising providing a workpiece fixture to retain the workpiece in position relative to each of the plurality of transfer devices during a material processing operation.

[c62] 62. The method of claim 59, wherein the housing is formed to provide a seal around at least the portion of the workpiece to be processed to retain the energy beam and any debris within the housing during a material processing operation.

[c63] 63. The method of claim 55, further comprising adapting the device to operate in at least one of substantially a vacuum and substantially a zero gravity environment.

[c64] 64. The method of claim 55, wherein disposing the at least one energy beam transfer device comprises mounting the at least one energy beam transfer device to a movable frame to direct the energy beam in the predetermined pattern.

[c65] 65. The method of claim 64, wherein mounting the at least one energy beam transfer device comprises mounting a lens to the movable frame.

[c66] 66. A method of making a device to inspect a workpiece, comprising:
providing a movable frame adapted to move relative to the workpiece;
mounting a laser holographic exciter to the movable frame; and
mounting at least one laser reader to the movable frame.

[c67] 67. The method of claim 66, further comprising providing a drive mechanism to move the movable frame relative to the workpiece.

[c68] 68. The method of claim 67, wherein providing the movable frame comprises providing a substantially horseshoe shaped member including:
an interior portion adapted to receive and retain the workpiece; and
a substantially circular exterior portion adapted to engage the drive mechanism to move the movable frame relative to the workpiece.

[c69] 69. The method of claim 67, further comprising forming a housing to enclose at least the movable frame and at least a portion of the workpiece under inspection, wherein forming the housing includes:
providing a first part; and
providing a second part movable relative to the first part to releasably enclose the portion of the workpiece under inspection.

[c70] 70. A method of making a device to process material, comprising:
providing a base member;
mounting a track to the base member; and

providing a material processing system adapted to move along the track to perform a material processing operation on a workpiece.

[c71] 71. The method of claim 70, further comprising:
providing a drive motor; and
coupling the material processing system to the drive motor to move the material processing system along the track.

[c72] 72. The method of claim 70, further comprising providing a laser holographic inspection system adapted to move along the track to perform an inspection operation on the workpiece.

[c73] 73.The method of claim 72, further comprising:
providing a drive motor; and
coupling the laser holographic system to the drive motor to move the laser holographic system along the track.

[c74] 74. A method of processing material, comprising:
generating an energy beam; and
directing the energy beam in a predetermined pattern on a workpiece through at least one energy beam transfer device.

[c75] 75. The method of claim 74, wherein directing the energy beam comprises applying the energy beam to a

plurality of energy beam transfer devices with a switching device.

[c76] 76. The method of claim 74, wherein directing the energy beam comprises directing one of an electron beam or a laser beam on the workpiece.

[c77] 77. The method of claim 74, further comprising enclosing the energy beam and at least a portion of the workpiece to be processed in a housing.

[c78] 78. The method of 74, further comprising positioning an energy beam transfer device at a predetermined location relative to the workpiece.

[c79] 79. The method of claim 78, wherein positioning the energy transfer device comprises moving a frame attached to the energy beam transfer device relative to the workpiece.

[c80] 80. A method of inspecting a workpiece, comprising:
projecting a laser holographic pattern on the workpiece;
moving the laser holographic pattern around a portion of the workpiece to be inspected; and
detecting any defects in the workpiece by observing the laser holographic pattern.

[c81] 81. The method of claim 80, further comprising enclos-

ing at least a portion of the workpiece to be inspected in a housing.

[c82] 82. The method of claim 80, wherein detecting any defects comprises observing the laser holographic pattern with at least one laser reader.

[c83] 83. The method of claim 80 wherein moving the laser holographic pattern comprises moving a laser holographic exciter relative to the workpiece.

[c84] 84. A method of processing material, comprising:
moving a material processing system along a predetermined path to perform a material processing operation; and
moving an inspection system along the predetermined path to perform an inspection operation.

[c85] 85. The method of claim 84, further comprising releasably holding and positioning a portion of material to be attached to a workpiece.

[c86] 86. The method of claim 85, wherein the portion of material comprises an ISO grid repair patch.

[c87] 87. The method of claim 85, further comprising directing a energy beam from the material processing system to attach the portion of material to the workpiece.

[c88] 88. The method of claim 87, wherein directing the energy beam comprises directing one of an electron beam or a laser beam material processing system.

[c89] 89. The method of claim 84, wherein moving the material processing system along the track comprises driving the material processing system with a carriage drive arm propelled by a drive motor.

[c90] 90. The method of claim 84, wherein moving an inspection system comprises moving a laser holographic inspection system along the predetermined path;

[c91] 91. The method of claim 90, further comprising detecting any defects by observing a laser holographic pattern projected on the processed material.

[c92] 92. The method of claim 90, wherein moving the laser holographic inspection system along the track comprises driving the laser holographic inspection system with a carriage drive arm propelled by a drive motor.